Incl #7 to
DPS-2207
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TECHNICAL PROPOSAL FOR MODIFICATION OF TWO (2) LIGHT-WEIGHT RECONNAISSANCE RADAR SYSTEMS

AAN-90195-B

1. Scope of Proposal

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This proposal describes work to be performed prior to installation of the Westinghouse Light-Weight Reconnaissance Radar [redacted] The items herein proposed are:

Item 1 - a. Modify two (2) Light-Weight Reconnaissance Radar Systems, (GFE) per Westinghouse drawing 406R600G01 by installing all previously issued field modifications, incorporating the latest design improvements and modifying the Recorder to accept in flight processing cameras. Perform electrical test on the new configuration.

b. Fabricate two antennas, AS-753(XH-C)/APQ-56 and AS-754(XH-C)/APQ-56.

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c. Inventory one lot GFE spares in possession of [redacted] and procure supplementary spare parts required to bring spares up to date.

Item 2 - a. Install all modification kits outstanding, inspect, adjust and retest two GPL-RADAN Navigator systems Model PC-210.

b. Inventory RADAN spares and replace missing items.

2. Description of Equipment Modification

Since the time of design and fabrication of the Westinghouse Light-Weight Radar System, various design improvements have been conceived. These design improvements allow increased radar performance and increased reliability of operation. A number of these improvements have been procured as kits by the services for installation in the field. [redacted]

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The modification kits previously procured by the Services applicable to the subject sets are:

Serial #1 and #2, 1, 2, 3, 5, 6, 7, 8, 9, 10, 11, 13, 15, 17, 18, 19, 20, 21, 22, 23, 25, 27.

Of the preceding kits, those not presently installed in the subject equipment are to be supplied to Westinghouse as GFE and will be installed.

The most recent series of design changes for improvement of performance of the equipment are mainly for increased display resolution. Certain of these changes, as described in paragraph 7, have been flight-tested in a low altitude installation (1,000 - 2,500 ft.) and have resulted in greatly improved display resolution and radar mapping performance. Although these design changes were specifically made for a low altitude installation, the proposed changes will provide a corresponding increase in high altitude operation. The following chart gives a more detailed description of these new design modifications:

Equipment change	Resulting Improvement
A. 1. Replace with new type components:	
a. Receiver pre-amp	Improve system resolution by a factor of approximately 1.5:1.
b. Receiver post-amp	
c. Recorder video-amplifier	
d. Recorder Cathode Ray tube	
e. 2 KV focus power supply	
2. Add dynamic focus circuitry	
3. Modify light level and gain control circuits.	Provide automatic CRT and receiver gain adjustment to permit optimum mapping under conditions of either strong or weak signals.

B.	Replace center section of RF switch waveguide block with new assy.	Reduce switch losses to less than 0.5 db in all switches.
C.	Delete magnetron current regulating Magamp from RF head and replace saturable reactor in modulator with a new current regulator and adjustment panel. Change despiking coil in modulator and add RC despiking coil in RF head. Change switch and edge lit panel on control panel.	Improve magnetron current regulation thereby decreasing frequency drift and tuning problems. Permit operation of magnetrons at currents as low as 3 ma average current for reduced power output, narrower pulse widths, and longer life where such operation is applicable (ground or low altitude operation).
D.	Delete chopper from Monitor. Replace with electron tube equipment.	Increase reliability. Choppers have had excessive failure rate.
E.	Modify recorder to accept 9 1/2" in-flight processing.	Permit use of present 5" non-processing camera of 9 1/2" in-flight processing camera.

After the above listed modifications have been incorporated, the equipments will conform to Westinghouse drawing 406R600G01 and will be tested to meet the electrical requirements of these latest configurations. (Drawing 406R600G01 will be available by 1 June 1958). Any replacement parts required for original circuits will be GFE, that is, spare parts expended while above modifications are performed will be drawn from Navy spares.

3. <u>Fabrication of Antennas (Item 1b)</u>

The antennas to be supplied are identical to those presently in use with the AN/APQ-56(XH-4). They are slotted waveguide feed, fifteen feet long, with dielectric lens optimized for 0-18 mi mapping from 36,000 ft. altitude.

4. Spare Parts Procurement (Item 1c)

One lot of spares applicable to the subject radar equipments has been inventoried. The listing of spares in Appendix A cover 3 areas. Group I is a listing of applicable spares necessary to bring the GFE spares lot up to full strength. Since the equip-

25X1 ments are to operate at a [redacted] test center, only those items marked with an asterisk are recommended. Group II is a listing of spares recommended because of the installation of the field modification kits into the equipments. Group III is a listing of the spares required to support the new circuits to be installed in the equipment.

5. RADAN Modification (Item 2a)

The RADAN Navigation System PC-210 are to be modified to include the latest applicable modifications and retested by General Precision Laboratories, Inc. The equipments are to be GFE and any replacement parts required for original circuits are to be GFE.

6. RADAN Spares

One lot of GFE spare parts applicable to the RADAN equipments will be inventoried and replacement spares procured by GPL.

7. Description of Flight-Tested Modifications

The purpose of the low altitude modification to the Ground Mapping Radar (Time Shared) 2JA7390G01 was to improve target resolution and the receiver transfer characteristic.

This radar originally was designed for only high altitude operation with a 15 mile range. This emphasized the problem of obtaining sufficient return from poor radar targets. The best available cathode ray tube with a 15 mile sweep seriously limited resolution. Because of these limitations, the transmitter pulse was made wider and the receiver bandwidth narrower than is desirable at low altitudes and short ranges.

The receiver automatic gain control (AGC) was designed to keep the noise at a constant level independent of the return signal strength. Therefore, receiver gain was optimum for weak signals. Since the great majority of ground return is comparatively weak, this method is satisfactory when flying at altitudes from 20,000 to 70,000 feet. However, when flying at low altitudes (below 5,000 feet), the signal return was strong from most targets. Hence the film was typically too dark. In other words the AGC system was not flexible enough to compensate for wide variations in typical signal return.

In order to improve the system performance at low altitudes, a modification program was started early in December 1957 and completed on January 23, 1958.

To improve range resolution, the transmitter pulse width was decreased to 0.07 microsecond in the LOW POWER position. The average power output is 8 watts and the peak power output is 57 kilowatts. This is more than enough power for a five mile range at low altitude. Running the magnetron at 50% of its rated power output is likely, also, to increase the life of the tube.

To improve range resolution, a new wide-band receiver was installed in the radar. The combined 3 db bandwidth of the new pre-amplifier and post-amplifier is about 15 megacycles. The new post-amplifier is a linear amplifier, whereas the old post-amplifier was non-linear in order to increase the input signal dynamic range of the receiver. Because of the difficulty in designing a wide band, non-linear amplifier, it was decided to use a linear post-amplifier in order to obtain better resolution.

For improvement in both range and track resolution, the previously used cathode ray tube in the Recorder was replaced by a new Westinghouse WX3751 tube which has a 0.0015 inch line width as compared to the .003 inch line width of the previously used tube. The new cathode ray tube requires more focus supply current and a greater video drive than the old tube. Otherwise the physical and electrical requirements of the two

tubes are the same.

In order to supply the increased focus grid current for the new cathode ray tube, a modified 2,000 volt power supply was installed in the Recorder. The focus current requirement can be as much as 500 microamperes peak. Since the optimum focus voltage can be different for different spot positions on the face of the cathode ray tube, a dynamic focus circuit was added to the Recorder.

A new video amplifier design is utilized. Since the new post-amplifier does not have a seconddetector, one double-tuned I.F. stage and a second detector are included on the video amplifier chassis. This enables the video limiter to be D.C. coupled to the second detector. The unblanking, rectangular waveform is fed into the limiter along with the video signal, so that the limiter tube is cut-off during the sweep off time. The clamping diodes at the output of the video amplifier operate on the limit signal level rather than on the small signal level. This eliminates the difficulty of clamping diodes attenuating small signals. The video output stage is designed for a maximum output amplitude of about 35 volts, because of the increased drive requirement of the new cathode ray tube. This drive is sufficient for use with a five mile sweep; however, as much as 45 volts may be necessary when using a three mile sweep. Additional drive may be obtained by increasing the bias or decreasing the bandwidth of the output stage.

The new video amplifier includes an AGC detector which adjusts the gain of the receiver so that the video signal exceeds a fixed threshold for 1/4 of the unblanking time or 1/2 of the signal sweep time. The output of the AGC is fed through a cathode follower in the old AGC amplifier chassis to the post-amplifier.

If the limiter stage bias were constant, the background light level on the cathode ray tube would vary as the AGC changed the post-amplifier gain and noise output. However, by using the light meter output in a feedback loop to vary the limiter bias, the background light on the cathode ray tube is held constant as the receiver gain changes.

Since the clamping diode at the video output operated on limit level, changing the limiter bias has the effect of changing the cathode ray tube bias. This feedback loop is referred to as the automatic bias control. (ABC).

The combination of the new AGC and ABC provides a flexible receiver which can adjust itself to extremely large variations in signal level. This receiver should operate at optimum receiver gain and background light level when the return signals are weak as well as strong. The input signal dynamic range of the receiving system is about 30 db. The AGC and ABC move the usable dynamic range up or down so that it is centered at the signal level containing most of the useful information. (The "input signal dynamic range" is defined as the ratio of the maximum input signal to minimum input signal which can be detected at the output without excessive distortion). As the receiver gain and cathode ray tube bias change, the dynamic range will change very little.

There is some question as to what the dynamic range of a ground mapping radar receiver should be. It has been considered that perhaps a dynamic range of 40 or 50 db would be better than 30 db. The dynamic range of a receiving system can be increased by using non-linear amplifiers to compress the input signal. However, it is very difficult to build a wide-band, non-linear amplifier of the type required for a mapping radar. For this reason linear amplifiers were used in the receiver except for the video limiter which does compress strong signals slightly before limit level is reached. An examination of the first flight test results indicate that a dynamic range of 30 db is sufficient for the large majority of signals. It is probably not desirable to increase the dynamic range unless an easily attainable method can be found for doing so.